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Short Communication

Application of artificial intelligence technology in monitoring students' health: Preliminary results of Syiah Kuala Integrated Medical Monitoring (SKIMM)

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Abstract

Health promoting university is a holistic approach to health that uses higher education settings to create a learning environment that improves the health and well-being of the campus community in a sustainable manner. The utilization of technology such as artificial intelligence (AI) could be one of the main success factors in the implementation of health-promoting universities to increase the effectiveness and efficiency of all stages of activities carried out in health promotion and prevention efforts. Integrated monitoring with the utilization of AI in this program is conducted to evaluate the health status of the students. The Syiah Kuala Integrated Medical Monitoring (SKIMM) has three components of continuous health status evaluation: vital signs, nutritional status, and burnout status. Health status monitoring was conducted continuously for three months among medical students at the Faculty of Medicine Universitas Syiah Kuala, Banda Aceh, Indonesia. This system uses the WhatsApp application as a platform to monitor health status. Student health monitoring in this program consists of two main activities: the health measurement phase and the health monitoring phase. The use of the SKIMM system to monitor students' vital signs, nutritional status and burnout status through the use of AI significantly raises students' awareness to conduct timely self-examination and enables sustainable healthy lifestyle behavior change. The adoption of AI technology allows for continuous health promotion to the entire academic community, including students in implementing the health promoting university.

Keywords: Health promotion, health monitoring, healthy university, artificial intelligence, SKIMM

Introduction

The World Health Organization (WHO) defines health as a state of overall physical, mental, and social well-being and not merely the absence of disease or disability [1]. One of the steps in striving for health is to carry out health promotion on an ongoing basis. Health promotion is a process that enables individuals or communities to control and improve their health. Health promotion is an important element in realizing community health and well-being, which includes actions to address the determinants of health, such as the social, economic, cultural, and political conditions in which a person is born, grows and develops that affect health status [2,3]. This

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demonstrates that health promotion is not solely the responsibility of the health sector, nor is it limited to individuals adopting a healthy lifestyle. Health promotion is multisectoral in nature, which is concerned with the involvement and mobilization of various sectors. Thus, health promotion is multidimensional in nature, consisting of various interrelated activities: (a) communication or raising public awareness; (b) education to empower individuals and groups towards behavior change; and (c) advocacy and formulation of organizational policies that promote healthy decision-making; and (d) environmental and structural changes to produce policies and decisions that are health-minded for public [4].

Given the many benefits of health promotion, every higher education institution should adopt holistic and comprehensive health promotion policies and programs. This will increase the potential and contribution of higher education institutions to the health and well-being of society and enhance the value of higher education through (1) health protection and promoting the well-being of students, staff and the general public in their policies and activities; (2) continuously linking health promotion with teaching, learning and research; (3) development of health promotion alliances and community outreach; (4) implementation of occupational health-related programs; and (5) promotion of environmentally friendly technologies for sustainability [5]. In addition, implementing health promotion programs and policies will enable higher education institutions to carry out the functions of higher education effectively and efficiently, including education, research, and community service [6]. Lecturers, students, researchers, and staff will be better prepared physically, mentally, and psychologically to participate more actively in the process of disseminating and utilizing knowledge. It is expected that they will be in a better condition to provide services to students and the community through advocating for policy changes. The development and mobilization of human resources (HR) will be more optimal, where each sector carries out its roles and responsibilities based on the vision, mission and goals of the institution [7]. Furthermore, the development of higher education institutions as health-promoting universities will add value through a positive public image, improve the ranking of universities and become a benchmark for many other educational institutions [5,8].

Health promoting university is a holistic approach to health that uses higher education settings to create a learning environment that improves the health and well-being of the campus community in a sustainable manner [9]. As a concrete manifestation of the implementation of health-promoting universities, in 2019, the Ministry of Health of the Republic of Indonesia, together with several higher education institutions in Indonesia, initiated a healthy campus program [10]. Healthy campus is a movement for healthy living in the higher education setting. The purpose of this program is to make the campus community, which consists of students, lecturers or teaching staff, administrative staff and other supporting components to be healthy as a whole through activities focused on prevention, education and health promotion. Healthy campus is a development of health promotion programs in schools and Islamic boarding schools that have been started by the Indonesian Ministry of Health for several decades [11].

The utilization of technology such as AI could be one of the main success factors in the implementation of health-promoting universities to increase the effectiveness and efficiency of all stages of activities carried out in health promotion and prevention efforts. Implementing AI for health promotion in university settings can take various innovative forms, each aiming to enhance the well-being of students and staff. The use of animal-assisted interventions (AAIs) to monitor student and staff stress and anxiety on university campuses in Australia has shown success in promoting the health and well-being of students and staff [12]. The deployment of AI-integrated smart robots to monitor health protocols, body temperature and indoor environment in university classrooms proved to improve safety and effectively implement post-COVID-19 preventive measures at the University of Technology and Applied Sciences - Al Musanna, Oman [13]. However, studies assessing the effectiveness of AI applications in the implementation of health-promoting universities are limited. The aim of this study was to implement the application of AI during the activities within health-promoting university programs and to evaluate its effectiveness.

Methods

Development of Syiah Kuala Integrated Medical Monitoring

To support the implementation of the healthy campus program at Universitas Syiah Kuala, Banda Aceh, Indonesia, an integrated AI-based digital technology called Syiah Kuala Integrated Medical Monitoring (SKIMM) was developed. AI refers to the automation of intelligent behavior. This includes things like learning, reasoning, problem-solving, perception, and understanding natural language. The engineering goal of AI is to acquire ability in the machine so that it can solve the real-life problems [14]. Meanwhile, SKIMM is an integrated medical monitoring program in the ecosystem of the Faculty of Medicine, Universitas Syiah Kuala, Banda Aceh, Indonesia, using AI technology. This system is an innovative product in collaboration with the BotMD Care platform (Singapore). This system uses the WhatsApp application as a platform to monitor individual health status.

Student health monitoring in this program consists of two main activities: the health measurement phase and the health monitoring phase (**Figure 1**). The health screening phase was first initiated at the campus health post (CHP), facilitated by campus health workers. In addition, after obtaining initial data, the SKIMM system is activated using the student's phone number registered on the WhatsApp platform. The student then performs the examination independently and reports the results of the examination periodically through the SKIMM system. If a specific health problem is found, the system will automatically encourage students to visit the campus health center for a follow-up plan.

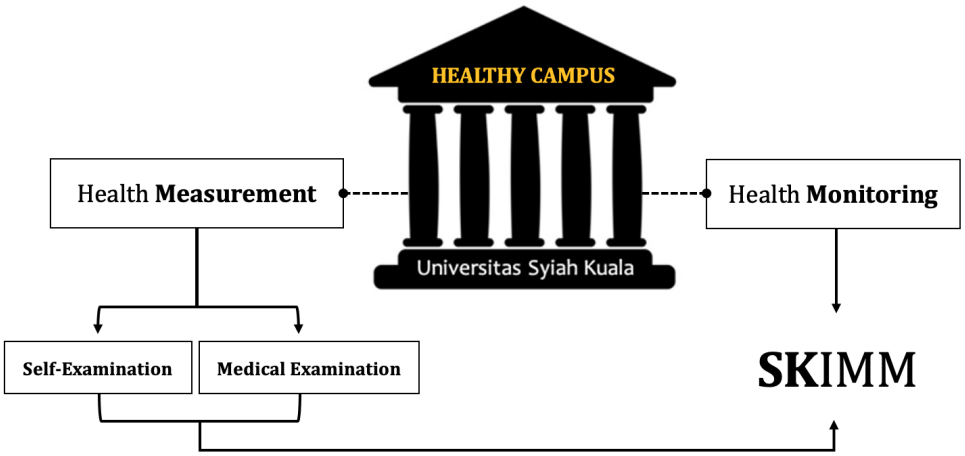

Figure 1. Diagram of Syiah Kuala Integrated Medical Monitoring (SKIMM) activity.

Study setting and design

A prospective cohort study was conducted among active students at the Faculty of Medicine Universitas Syiah Kuala, Banda Aceh, Indonesia, using a purposive sampling technique. The students involved consisted of three different stages of education, starting from the first year (class of 2021), second year (class of 2020) and third year (class of 2019). There were three components of continuous health status evaluation: vital signs (module 1), nutritional status (module 2), and burnout status (module 3). Health status monitoring was conducted continuously for three months (August to October 2022). The data is presented descriptively including frequency, percentage, and mean value of each evaluation component.

SKIMM operational stages

During the monitoring period, students went through the stages of SKIMM operational stages systematically. The SKIMM operational system had eight steps, known as "8A", with the following description. (1) Activation, the initial stage when students are registered into the SKIMM system. Activation officers collected data on personal identity and contacts connected to the WhatsApp application. (2) Assessment, after being registered in the SKIMM system, students will be examined by health workers, including vital signs, anthropometry, and other special statuses. (3) Access, students met the doctor for additional examinations as needed, and a follow-up

monitoring schedule will be determined according to the results of the examination. (4) Agenda, students were scheduled for a follow-up examination. Notifications were sent automatically on WhatsApp according to the schedule. At this stage, students could conduct self-examination followed by self-report on the system. (5) Advice, students received feedback from the self-report based on AI analysis through their WhatsApp. The SKIMM operational system is presented in **Figure 2**.

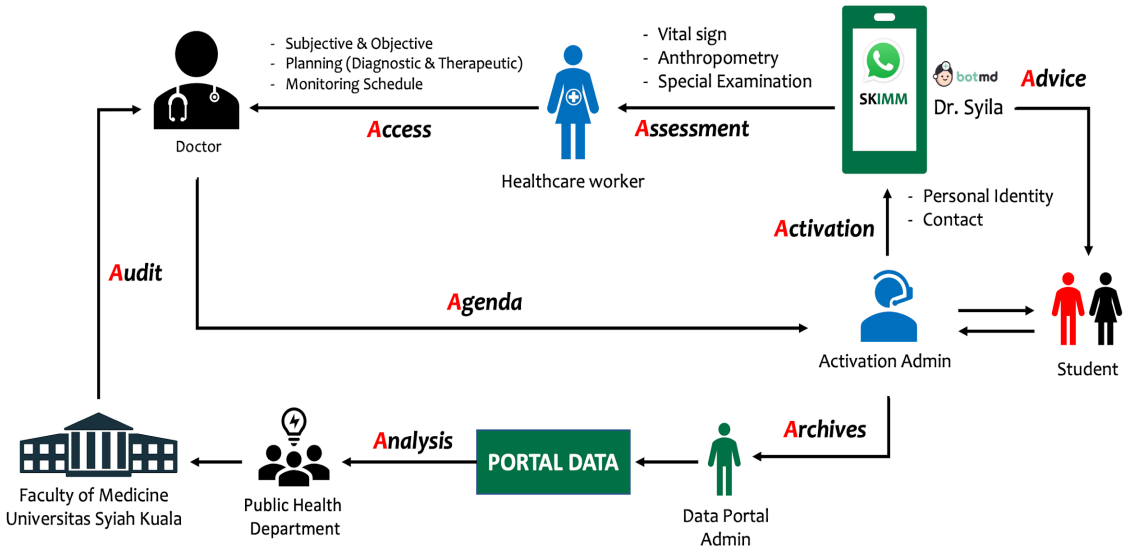

Figure 2. Syiah Kuala Integrated Medical Monitoring (SKIMM) operational system.

Implementation of the program

Student health monitoring in this program was conducted in two main activities, known as "2M" (measure and monitor). Health monitoring was conducted periodically using SKIMM. Both activities were carried out by applying AI technology to ensure the sustainability of benefits and increase the effectiveness and efficiency of the program.

Health measurements were conducted for all enrolment students at the Faculty of Medicine, Universitas Syiah Kuala, Banda Aceh, Indonesia. At the initiation stage, students had a medical examination program with the following stages. First, medical examinations were conducted by doctors and nurses, which included checking vital signs, nutritional status and basic physical examinations. Then, all examination data obtained were entered into the electronic system (SKIMM) independently by students facilitated by health workers. Periodic monitoring was conducted each month for three months by students independently and supervised by health workers at the CHP. Furthermore, health checks were carried out independently by students every month based on a predetermined time and all self-examination results were input into SKIMM. Health monitoring was carried out on all students electronically using SKIMM. Monitoring components include vital signs, nutritional status, and burnout status. During the monitoring using SKIMM, students met the doctor for additional examinations as needed, and a follow-up monitoring schedule was determined according to the results of the examination, including scheduled for a follow-up examination. All notifications were sent automatically on WhatsApp according to the schedule. At the health monitoring stage, students could conduct self-examination followed by self-report on the system, and they would get feedback from the self-report based on AI analysis through their WhatsApp.

Outcomes

Integrated health monitoring using AI in university settings was expected to significantly enhance health promotion, disease prevention, and personalized health management for students. The effectiveness indicators assessed for this program were the timeliness of the self-examination, the adaptability of the students to the use of AI and most importantly the willingness of the students to make behavioral changes in accordance with the recommendations based on the results of the health examination.

Results

System development

We developed the SKIMM using an AI-integrated system, which operates on the widely used WhatsApp platform, eliminating the need for a separate application. After the activation process, students will periodically get a command to conduct a self-examination and enter the results of the examination through the attached link. Then, when students click on the link, they will be directed to a web-based typeform (**Figure 3**) with an interactive display and detailed information. After all data is entered, students will automatically get an interpretation message based on the results of the examination along with providing special health recommendations in the form of educational messages or orders to visit the CHP if a specific health condition is found that requires special treatment. Data entered by students will be collected on a dashboard that can be accessed by program administrators and health workers at the CHP, allowing for remote monitoring and comprehensive reporting for both students as a whole or on a personal basis. Through this dashboard, officers can also provide customized message prompts as a follow-up step to student health status findings.

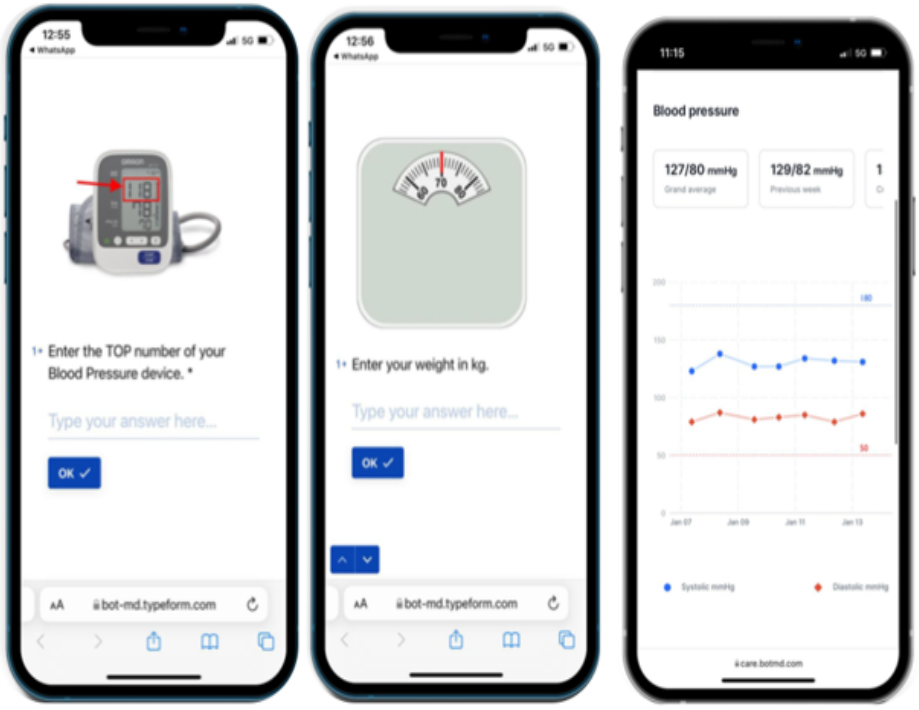

Figure 3. The user interface of Syiah Kuala Integrated Medical Monitoring (SKIMM) typeform.

Health monitoring

A total of 498 enrolled students at the Faculty of Medicine, Universitas Syiah Kuala, Banda Aceh, Indonesia, were involved in this study of which 173, 173 and 152 students were from Class of 2021, 2020 and 2019, respectively. On August 27–28, 2022, the first medical examination was conducted within the Faculty of Medicine Universitas Syiah Kuala campus. The average age of students who did the examination in the SKIMM program was 19.99±1.05 years with the dominance of females (69.7%).

The monitoring of the overall health status of students for three months using the SKIMM system are presented in **Table 1**. The average examination component in module 1 is still in the normal category. The same thing was also seen in module 2, the nutritional status of students was within the norm range (BMI <25 kg/m^2 and abdominal circumference <80 cm). However, the monitoring results of module 3 showed high exhaustion scores (>2.28) and disengagement scores (>2.1) every month which indicated that students were in burnout status.

Table 1. Overall health monitoring among enrolled medical students included in the study (n=498)

Examination	Monitoring wave		
	August	September	October
Module 1: Vital sign			
Systolic blood pressure (mmHg)	116.17	115.74	118.24
Diastolic blood pressure (mmHg)	77.99	77.97	77.97
Heart rate (times/minutes)	88.7	88.55	88.92
Temperature (°C)	36.35	36.49	36.24
Module 2: Nutritional status			
Body weight (kg)	60.06	59.57	60.78
Height (cm)	161.16	161.16	161.16
Body mass index (kg/m²)	23.54	22.94	22.68
Abdominal circumference (cm)	76.93	75.97	77.68
Module 3: Burnout status			
Exhaustion	2.57	2.56	2.57
Disengagement	2.31	2.34	2.53

Specific clinical findings in students during the monitoring process are presented based on monthly evaluations in **Table 2**. Clinical findings in module 1 were not found to have very significant changes in each month. In module 2, the body mass index of students, especially in the groups detected as overweight, obesity 1 and obesity 2, decreased gradually every month. This condition occurred due to specific advice given to students to change their lifestyle according to specific clinical findings on an ongoing basis using AI. In addition, the data entered by students in the SKIMM system will be forwarded to the medical team in charge of the program so that specific behavior modification interventions can also be provided directly. The same condition occurred in module 3, the burned-out, disengaged and exhausted status of students decreased from August to September, but monitoring from September to October tended to settle.

Table 2. Specific clinical findings in August, September, and October 2022

Clinical findings	2019 n (%)	2020 n (%)	2021 n (%)	Total n (%)
August 2022				
Module 1: Vital sign				
Systolic blood pressure ≥140 mmHg	2 (1.2)	8 (4.6)	7 (4.6)	17 (3.4)
Module 2: Nutritional status				
Underweight	21 (12.1)	30 (17.3)	41 (27.0)	92 (18.5)
Overweight	23 (13.3)	24 (13.9)	17 (11.2)	64 (12.9)
Obesity I	20 (11.6)	27 (15.6)	26 (17.1)	73 (14.7)
Obesity II	16 (9.2)	33 (19.1)	16 (10.5)	65 (13.1)
Abdominal circumference ≥90 cm (male)	10 (5.8)	14 (8.1)	12 (7.9)	36 (7.2)
Abdominal circumference ≥80 cm (female)	16 (9.2)	37 (21.4)	25 (16.4)	78 (15.7)
Module 3: Burnout status				
Burned-out	94 (54.3)	104 (60.1)	102 (67.1)	300 (60.2)
Disengaged	26 (15.0)	18 (10.4)	19 (12.5)	63 (12.7)
Exhausted	15 (8.7)	10 (5.8)	10 (6.6)	35 (7)
September 2022				
Module 1: Vital Sign				
Systolic blood pressure ≥140 mmHg	2 (1.2)	11 (6.4)	5 (3.3)	18 (3.6)
Module 2: Nutritional status				
Underweight	24 (13.9)	26 (15.0)	33 (21.7)	83 (16.7)
Overweight	17 (9.8)	22 (12.7)	16 (10.5)	55 (11.0)
Obesity I	16 (9.2)	18 (10.4)	24 (15.8)	58 (11.7)
Obesity II	12 (6.9)	29 (16.8)	12 (7.9)	53 (10.6)
Abdominal circumference ≥90 cm (male)	7 (4)	14 (8.1)	13 (8.6)	34 (6.8)
Abdominal circumference ≥80 cm (female)	18 (10.4)	35 (20.2)	16 (10.5)	69 (13.9)
Module 3: Burnout status				
Burned-out	92 (53.2)	68 (39.3)	88 (57.9)	248 (49.8)
Disengaged	17 (9.8)	27 (15.6)	17 (11.2)	61 (12.2)
Exhausted	7 (4)	14 (8.1)	13 (8.6)	34 (6.8)
October 2022				
Module 1: Vital Sign				
Systolic blood pressure ≥140 mmHg	2 (1.2)	9 (5.2)	4 (2.6)	15 (3.0)
Module 2: Nutritional status				

Clinical findings	2019 n (%)	2020 n (%)	2021 n (%)	Total n (%)
Underweight	25 (14.5)	27 (15.6)	31 (20.4)	83 (16.7)
Overweight	13 (7.5)	20 (11.6)	12 (7.9)	45 (9.0)
Obesity I	10 (5.8)	31 (17.9)	10 (6.8)	51 (10.2)
Obesity II	7 (4.0)	16 (9.2)	12 (7.9)	35 (7)
Abdominal circumference ≥90 cm (male)	12 (6.9)	17 (21.4)	14 (9.2)	43 (8.63)
Abdominal circumference ≥80 cm (female)	15 (8.7)	30 (17.3)	19 (12.5)	64 (12.9)
Module 3: Burnout status				
Burned-out	92 (53.2)	68 (39.3)	88 (57.9)	248 (49.8)
Disengaged	17 (9.8)	27 (15.6)	17 (11.2)	61 (12.2)
Exhausted	15 (8.7)	10 (5.8)	10 (6.6)	35 (7)

Discussion

From the student side, the SKIMM system allows them to view their personal health record resume. In addition, the SKIMM system allows for automatic medical advice based on AI analysis according to the examination reported. Because it uses WhatsApp, the SKIMM system will be very easy to use and does not require any special training.

Based on the key findings in **Table 1**, the AI feature at SKIMM can detect and indicate the condition of cardiovascular health, nutritional trends and mental well-being of the students during the study period. Hence, the application will respond accordingly towards each result acquired. For example, when the cardiovascular health is in a stable condition, SKIMM will continue monitoring the status of the students and reflect a positive indicator on the dashboard. Meanwhile, when the fluctuation happens in the body weight, SKIMM will suggest changes to be done in the nutritional status. Some healthy food or good eating habits will be suggested to the students. Similarly, when the consistent exhaustion and disengagement scores increase, SKIMM highlighted a warning sign to highlight potential mental health challenges. This is to indicate a need for further investigation and support. Some recommendations are like reducing the study load by reminding the students to prepare for the exams or to work on any assignment ahead of time.

At the same time, the analysis of specific clinical findings in **Table 2** highlights areas of concern and potential avenues for intervention among the studies population. For example, in module 1, with Systolic Blood Pressure ≥140 mmHg across the months observed, the percentage of individuals with high systolic blood pressure remained relatively stable. SKIMM indicates a consistent presence of elevated blood pressure, showing the percentages are within a manageable range.

Meanwhile, in module 2, SKIMM produces data that underscores the need for targeted interventions in nutritional education and weight management; hence, the impact shows a decrease in Obesity I noted from September to October while the rates of overweight and Obesity II remained stable. Also, SKIMM highlights the elevated abdominal circumference, particularly among females, which possesses a higher risk for metabolic complications, and suggesting interventions like tailored dietary plans and exercise programs. As for the concerning prevalence of burnout necessitates immediate action, SKIMM suggests potential strategies including stress management programs, mental health support, and promotion of work-life balance among students.

The use of AI in the student health status monitoring program is a promising modality to change health-conscious behavior and ensure the sustainability of the university's health promotion program. The two main components that play the most important role in the implementation of this technology are automatic reminders and advisors.

One of the best practices of utilizing AI for health monitoring is as done by the University of Surrey (United Kingdom) in the Horizon 2020 PeRsOnalized nutriTion for hEalthy livINg (PROTEIN) project, which aims to create an advanced AI tool that provides personalized nutrition recommendations to individuals. The PROTEIN AI Advisor tracks the user's diet, physical activity and health status using wearable sensors, and provides real-time AI recommendations to help meet evidence-based healthy eating targets [15]. The use of AI technology in this project has been utilized in a wide population and has been proven to provide

meal plan recommendations with 92% accuracy in both healthy people and people with certain health conditions that require specific nutritional supervision [16].

Finally, it is essential to consider the limitations of this study when interpreting the findings. The data is based on self-reported measurements, which may introduce bias. Additionally, the study was conducted within a specific university setting and focused on medical students, limiting the generalizability of the results to other populations. Also, there are several potential challenges faced by universities in the implementation of sustainable health promotion programs with the use of AI like the development of the SKIMM system including (1) data acquisition and training - the data is sensitive and complex; (2) technological development - lack of understanding among physicians about AI implementation, and the need for regulatory guidelines on safe implementation and assessment of AI technology; (3) ethical and social issues - privacy, data security, bias in algorithms, and regulatory compliance; (4) workforce adaptation - the fear that AI will replace jobs in healthcare can lead to distrust and reluctance towards AI-based solutions; and (5) regulatory barriers - the lack of clear guidance from regulatory bodies on evaluating the safety and efficacy of AI-based interventions. Universities should work with industry partners, regulatory agencies, and policymakers to address these issues by establishing clear guidelines for safe implementation, ensuring the ethical use of AI technology, and educating stakeholders about AI's role in the transformation of healthcare.

Conclusion

The implementation of AI for integrated student health monitoring in university settings is a multifaceted approach that leverages technology to enhance health outcomes, inclusivity, and the overall student experience. The adoption of AI technology allows for continuous health promotion to the entire academic community including students in order to realize a health promoting university. The use of the SKIMM system to monitor students' vital signs, nutritional status and burnout status through the use of AI effectively raises students' awareness to conduct timely self-examination and enables sustainable healthy lifestyle behavior change. The system also enables the collection of cohort data related to students' health status in a comprehensive manner, which further serves as a basis for program development and campus health policymaking.

Ethics approval

The study protocol was approved by the Medical Faculty, Universitas Syiah Kuala, Banda Aceh, Indonesia.

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Conflict of interest

All authors have no conflict of interested.

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Underlying data

All data underlying the results are available from the corresponding author upon reasonable request.

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